MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2021/2022 (TERM ID 2215)

EEL1166 – CIRCUIT THEORY / ERL1036 – ELECTRICAL CIRCUITS

(All sections / Groups)

24 FEBRUARY 2023
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **FIVE** pages including cover page with **FOUR** questions only.

2. Answer **ALL** questions and print all your answers in the answer booklet provided.

3. All questions carry equal marks and the distribution of the marks for each question is given.

Question 1

(a) Use **source-conversion theorem** to simplify the circuit shown in **Figure Q1(a)**. Then determine the voltage, V_X in the circuit using superposition theorem. (Note: Re-sketch the circuit diagram and show your calculation for each step of the source-conversion.) [12 marks]

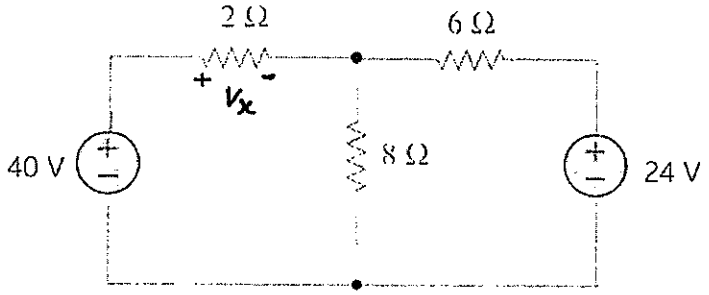
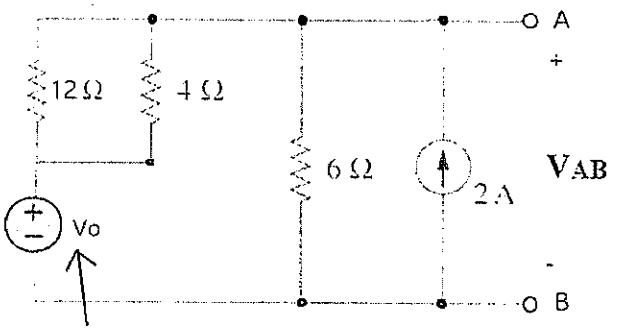


Figure Q1(a)

(b) A circuit with two independent sources is shown in **Figure Q1(b)**. Use **Thevenin's theorem** to determine the R_{TH} and V_{TH} between nodes **A** and **B**. Re-sketch the circuit diagram for each independent source and show all your calculation steps. **Do not** use source-conversion theorem to answer the question.
(Note: If your student ID is 121124**34**, use the last 2 digits, so *Vo* is 34V.) [13 marks]



Voltage source whose value is equal to the last 2 digits of student ID number

Figure Q1(b)

Continued...

Question 2

(a) Determine voltages, V_1 and V_2 in the circuit shown in **Figure Q2(a)** using **nodal analysis**. [13 marks]

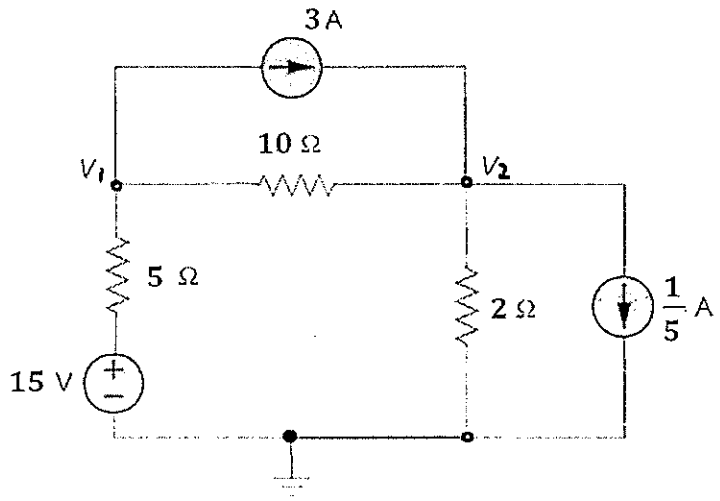


Figure Q2(a)

(b) Use **mesh analysis** to determine the currents, i_1 and i_2 in the circuit shown in **Figure Q2(b)**. [12 marks]

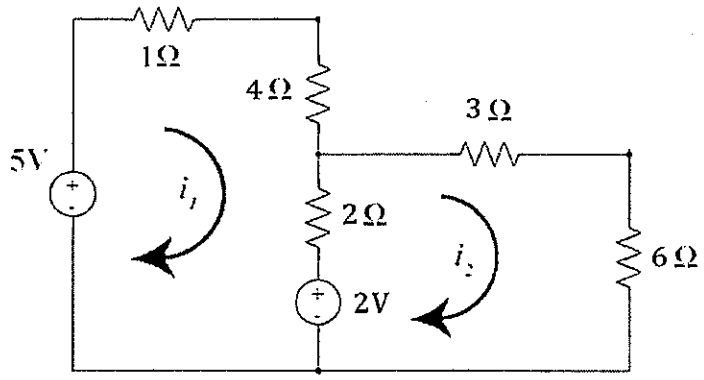


Figure Q2(b)

Continued...

Question 3

(a) For the circuit shown in **Figure Q3(a)**:

(i) define complex power, real power and reactive power. [5 marks]

(ii) determine the impedance, Z_1, impedance, Z_2 and hence the total impedance, Z_T. [7 marks]

(iii) calculate the total complex power, S, real power, P and reactive power, Q of the circuit. [5 marks]

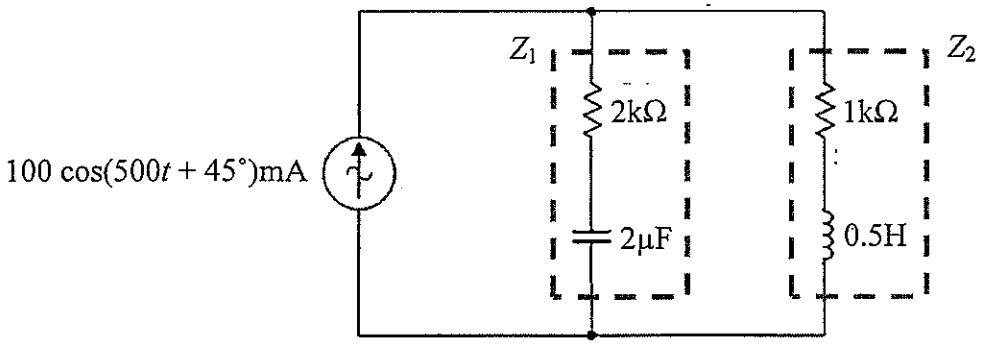


Figure Q3(a)

(b) A series resonance circuit has an unknown resistance of R Ω, a capacitance of 0.1mF and an inductance of L H. It requires a high quality factor of 100. Assume that the L = (sum of *last two digits of your student ID*) + 1H. Calculate the following:
(Example: student ID = 1201100**401**, L = (**0** + **1**) + 1H = 2H.)

(i) resonant frequency, ω_0. [2 marks]

(ii) resistance, R. [2 marks]

(iii) half-power bandwidth, B and its respective cut-off frequencies, ω_L and ω_H. [4 marks]

Continued...

Question 4

(a) A circuit shown in **Figure Q4(a)** has a switch, **S1** opened for a long time prior to $t = 0$. It is connected initially to terminal **A** at $t \geq 0$s and then, switched to terminal **B** at $t \geq 5$s.

(i) Analyse the circuit by deriving the mathematical expression of the capacitor voltage, $v_C(t)$ for $t \geq 0$s. [7 marks]

(ii) Analyse the circuit by deriving the mathematical expression of the inductor current, $i_L(t)$ for $t \geq 5$s. Then, obtain the voltage, v_R for $t \geq 5$s. [8 marks]

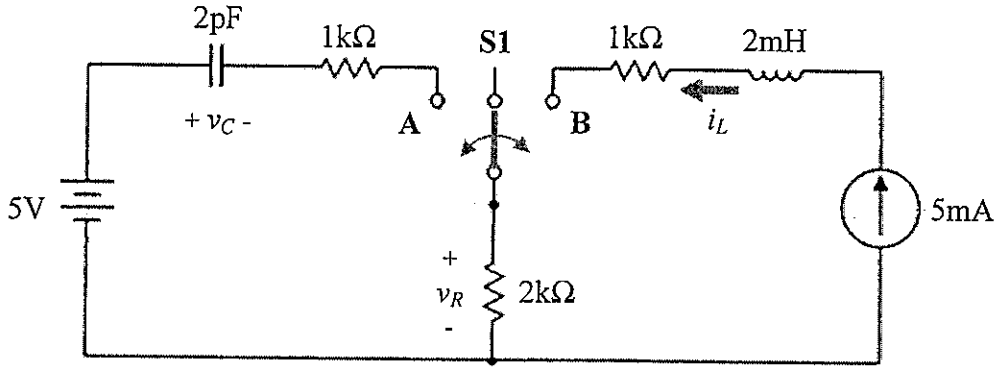


Figure Q4(a)

(b) A source-free **series** *RLC* circuit has a characteristic equation as follows:

$$s^2 + 5s + Ka = 0,$$

where K = (sum of *last two digits of your student ID*) + 1.
(Example: student ID = 1201100401, K = (**0** + **1**) + 1 = 2.)

(i) What are the differences between critically damped response, underdamped response and overdamped response? [4 marks]

(ii) Deduce the unknown value, a, so that the circuit exhibits a critically damped output response. [4 marks]

(iii) Based on the result obtained for part (b)(ii), determine the resistor required for the *RLC* circuit if the inductor and capacitor are given as 5H and 10F, respectively. [2 marks]

End of Paper